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Human Equilibrium Index (HEI / IEH)

A composite measure designed to evaluate humanity's progress, placing the family as the fundamental core of social balance and advancement.

1. Executive Summary

The **Human Equilibrium Index (HEI / IEH)** quantifies human progress by placing the family at the center of social stability. It integrates four components—**Balance (B)**, **Structural amplification (F⁺)**, **Social energy (S)**, and **Adaptability (D)**—into the formula

$$IEH = B \cdot F^{1.5} \cdot S \cdot D$$

The exponent 1.5 on F is proposed as an initial value because it amplifies the contribution of institutional strength without allowing F to dominate the index entirely; its final value should be determined through sensitivity analysis and empirical validation using 2010–2025 data and may be regionally adjusted where the evidence supports it.[cite:23][cite:22] This document adapts the methodology for global computation, defines operational indicators and data sources, outlines calibration processes and a 2026–2030 rollout plan, and specifies technical, validation, and governance requirements.[cite:32][cite:35]

2. Global Operational Definition of Variables

- α_1 — **Family capacity (0–1)**: weighted average of household economic stability, access to childcare and work–family balance, and caregivers’ mental health and psychosocial support.[cite:32][cite:36]
- α_2 — **Social embeddedness (0–1)**: weighted average of community participation, perceived social cohesion, and access to basic services and adequate housing.[cite:37][cite:40][cite:41]
- **F (Structural strength, 0–1)**: coverage and quality of family-oriented support networks and institutions, including social protection, childcare, and family programmes.[cite:32][cite:35]
- **S (Social energy)**:

$$S = \frac{\alpha_1 + \alpha_2}{2}$$

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- **B (Balance):**

- If $|\alpha_1 - \alpha_2| \leq \tau$, then $B = 1$.
- If $|\alpha_1 - \alpha_2| > \tau$, then

$$B = \exp(-k(|\alpha_1 - \alpha_2| - \tau)^2)$$

- **D (Adaptability):**

$$D = \frac{1}{1 + e^{-m(ds-0.5)}}$$

where dS is the relative change in S over the chosen time window.[cite:23][cite:29]

3. Suggested Indicators and Mapping to α

3.1 For α_1 (Family Capacity)

- Household economic stability: percentage of households with sufficient income to cover basic needs for 3+ months. Sources: household surveys, social protection registries.[cite:32][cite:35]
- Childcare and work–family balance: percentage of families with regular access to childcare or compatible work schedules. Sources: local government records and labour force surveys.[cite:32][cite:36]
- Caregivers’ mental health: standardized scores of stress or depression among primary caregivers. Sources: community health surveys and OECD social well-being reporting.[cite:35][cite:43]

3.2 For α_2 (Social Embeddedness)

- Community participation: percentage of households participating monthly in community networks or activities.[cite:37][cite:40]
- Perceived social cohesion: standardized score of interpersonal trust and social support (0–1). Sources: Gallup World Poll and national surveys.[cite:37][cite:40]
- Access to basic services and adequate housing: percentage of households with water, electricity, and non-precarious housing. Sources: censuses, administrative records, and SDG-style service coverage datasets.[cite:41][cite:44]

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3.3 Normalization and Aggregation

All primary indicators are transformed to a 0–1 scale by country or region and then combined through weighted averages to obtain α_1 and α_2 . The weighting scheme, its theoretical justification, and the results of sensitivity tests to alternative weights should be explicitly documented so that the impact of normative choices on IEH scores and rankings remains transparent and auditable.[cite:23][cite:29]

4. Initial Parameters, Regional Calibration, and Sensitivity

4.1 Initial Parameter Values

Initial global parameter values are proposed as:

- $\tau = 0.08$
- $k = 50$
- $m = 10$

These values are starting assumptions and should not be treated as final until cross-regional calibration and robustness checks are completed.[cite:23][cite:29]

4.2 Regional Calibration

Parameters τ , k , m , and the exponent on F should be calibrated using 2010–2025 historical data at country and subnational levels. Calibration can be conducted by regional blocs such as Sub-Saharan Africa, South Asia, East Asia, Middle East and North Africa, Europe, Latin America and the Caribbean, North America, and Oceania, balancing goodness of fit with cross-regional comparability.[cite:23][cite:32][cite:41]

4.3 Structural and Parameter Sensitivity Analysis

A systematic sensitivity analysis is required to assess the robustness of IEH to methodological choices.[cite:23][cite:26][cite:29]

- **Univariate and multivariate parameter sweeps:** vary τ , k , m , and the exponent on F over plausible ranges by region and track changes in the distribution of IEH, country and subnational rankings, and the relative sensitivity of B, S, F, and D.[cite:23][cite:26]

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- **Elasticities of IEH:** approximate partial derivatives $\frac{\partial IEH}{\partial \theta}$ for each parameter $\theta \in \{\tau, k, m, \text{exponent of } F\}$ to identify dominant parameters and stable ranges.[cite:23]
- **Robust parameter sets:** retain combinations that preserve the relative structure of IEH scores and rankings under small perturbations, reducing over-dependence on arbitrary assumptions.[cite:23][cite:29]

5. Empirical Validation and External Comparisons (2010–2025)

To position IEH as a policy-ready global index, a dedicated empirical validation programme should use 2010–2025 data at country and subnational levels.[cite:22][cite:25][cite:41]

5.1 Convergent and Discriminant Validity

Correlations and regression models should be estimated between IEH and established metrics such as the Human Development Index, the Social Progress Index, multidimensional poverty indicators, homicide rates, social unrest indicators, forced migration, and health and education outcomes.[cite:25][cite:28][cite:44] High correlation is expected where theory predicts alignment, while meaningful divergence is valuable where IEH captures family- and cohesion-related vulnerabilities that HDI or GDP per capita may miss.[cite:22][cite:44]

5.2 Crisis-Prediction Capacity

The model should be tested on whether low IEH levels or abrupt declines anticipate critical events such as mass protests, violent conflict, humanitarian emergencies, food insecurity spikes, or surges in irregular migration.[cite:19][cite:27][cite:41] Time-series models and classification algorithms such as logit, random forest, and gradient boosting can estimate crisis probability as a function of IEH trajectories and its components, with performance assessed through AUC, precision-recall, and Brier score under out-of-sample validation.[cite:19][cite:27]

5.3 Temporal Stability Versus Noise

Temporal stability of IEH and its sub-indices should be assessed using autocorrelation, coefficients of variation, and structural break tests to ensure the index is sensitive to genuine structural change rather than dominated by measurement noise or short-term volatility.[cite:23][cite:26]

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5.4 Content and Construct Validity

Expert panels and local stakeholders should evaluate whether observed IEH levels and changes are consistent with qualitative field knowledge. Their feedback should inform revisions to indicator definitions, weights, thresholds, and parameter values prior to full global deployment.[cite:28][cite:41]

6. Empirical Applicability of IEH Using Existing Data Infrastructures

The empirical implementation of the Human Equilibrium Index is strongly supported by existing cross-national data ecosystems. The OECD Family Database, together with complementary sources such as the CORESIDENCE Database, Gallup World Poll, UNDP Human Development Data, and SDG-oriented service indicators, already provides most of the variables needed to construct IEH components across OECD countries and a large set of non-OECD countries.[cite:32][cite:36][cite:38][cite:41][cite:44]

6.1 Applicability of Family Capacity (α_1)

The OECD Family Database provides more than 70 indicators on family structure, labour market position of families, public policies for families and children, and child outcomes across OECD and partner countries.[cite:32][cite:36] Indicators such as household income, poverty risks in families with children, childcare coverage, parental leave, and female employment can be used directly to build sub-indices of household economic stability and work–family reconciliation, which are the core of α_1 . [cite:32][cite:35][cite:39] The CORESIDENCE Database adds detailed national and subnational indicators on household structure for 156 countries over 1964–2021, strengthening the feasibility of measuring caregiving capacity and intergenerational support.[cite:38]

6.2 Applicability of Social Embeddedness (α_2)

The OECD concept of social cohesion is built around social inclusion, social capital, and social mobility, which closely matches IEH’s emphasis on community participation, perceived cohesion, and access to services.[cite:37][cite:40] OECD reporting on social connections and loneliness provides indicators on social contact, network size, and loneliness, while UNDP and SDG-style datasets provide data on access to services and living conditions.[cite:43][cite:46][cite:41] This makes α_2 empirically implementable in OECD settings and broadly feasible in global settings.[cite:40][cite:41][cite:43]

6.3 Applicability of Structural Strength (F)

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Family policies and institutional support are explicitly measured in the OECD Family Database and related work on family policy regimes, including public spending on family benefits, childcare coverage, parental leave generosity, and cash benefits.[cite:32][cite:35][cite:36][cite:39] Empirical analyses link these variables to child well-being, reduced child poverty, female employment, and other family-related outcomes, supporting the assumption that F acts as a meaningful structural amplifier rather than a neutral background factor.[cite:35][cite:36][cite:39]

6.4 Applicability of Social Energy (S), Balance (B), and Adaptability (D)

S is directly computable once α_1 and α_2 are constructed, and B can be estimated from the mismatch between them using the proposed threshold-and-penalty structure.[cite:23][cite:29] The OECD and JRC literature on composite indicators supports this kind of multidimensional aggregation and sensitivity-based interpretation.[cite:23][cite:29] Adaptability D is also implementable because many relevant family, employment, poverty, and social-connection indicators are available as time series in OECD, UN, and national statistical systems, allowing the calculation of dS over rolling windows and the testing of early-warning properties.[cite:35][cite:41][cite:44]

6.5 Applicability Assessment Table

IEH component	Concept in IEH	Main data dimensions needed	Existing data sources (examples)	Applicability assessment
α_1 Family capacity	Economic stability, childcare access, caregivers' mental health	Household income and poverty, parental employment, childcare coverage, mental-health indicators	OECD Family Database; DHS/MICS; national labour and health surveys; CORESIDENCE Database	High: strong OECD coverage and meaningful extension to many non-OECD settings.[cite:32][cite:36][cite:38]

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α_2 Social embeddedness	Community participation, social cohesion, basic services	Social contact, trust, participation, housing and service access	OECD social cohesion and social connection reporting; Gallup World Poll; UNDP/SDG indicators; censuses	High in OECD and moderate-high globally where social and service data exist.[cite:37][cite:40][cite:41][cite:43]
F Structural strength	Family-oriented institutions and policy support	Family spending, childcare coverage, parental leave, family services	OECD Family Database; Society at a Glance; social protection statistics	High in OECD; moderate globally with complementary World Bank and UN sources.[cite:32][cite:35][cite:39]
S Social energy	Aggregate state of family and social conditions	Combined information from α_1 and α_2	Derived from above sources	Directly computable once α_1 and α_2 are estimated.[cite:23][cite:29]
B Balance	Degree of mismatch between family capacity and social embeddedness	Joint distribution of α_1 and α_2 ; threshold τ	Same sources as α_1 and α_2	Computable with existing data; interpretation consistent with fragmented cohesion frameworks.[cite:40][cite:23]
D Adaptability	Dynamic response of S to shocks	Time series of S over 3–12 month or annual windows	OECD, UNDP, national statistics, social protection time series	High for OECD; feasible globally with annual data and careful uncertainty reporting.[cite:35][cite:41][cite:44]

6.6 Applicability Conclusions

The IEH model is empirically implementable today for OECD and many non-OECD countries using existing databases such as the OECD Family Database, CORESIDENCE, Gallup, UNDP, and SDG-oriented indicators.[cite:32][cite:36][cite:38][cite:41][cite:44] Its components map cleanly onto already measured dimensions of family outcomes, social cohesion, and family policies, and its

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composite-indicator methodology is consistent with established OECD and JRC practices on robustness and sensitivity.[cite:23][cite:29][cite:40] The main practical challenges lie in data quality and coverage in low-income contexts, but these can be handled through transparent imputation, uncertainty quantification, and fairness-oriented governance rather than through unrealistic data requirements.[cite:21][cite:23][cite:41]

7. Global Computation Methodology

1. **Data ingestion and harmonisation:** ETL pipelines integrate DHS, MICS, Gallup World Poll, UNICEF, OECD, national censuses, and relevant satellite-based products into a harmonised infrastructure.[cite:32][cite:35][cite:41]
2. **Imputation and quality control:** statistical and AI models are used to impute missing series and estimate uncertainty intervals through bootstrap or similar methods.[cite:21][cite:23]
3. **Sub-index computation:** after normalisation, compute α_1 , α_2 , S, B, F, D, and IEH for each geographic unit.[cite:23][cite:29]
4. **Contextual adjustment:** apply transparent cultural and structural adjustment factors where appropriate.[cite:28][cite:41]
5. **Time-series generation:** calculate dS over rolling windows (3, 6, and 12 months) to feed the adaptability component D and construct early-warning trajectories.[cite:35][cite:41]
6. **Publication and API:** publish IEH values and components through datasets, dashboards, and APIs for researchers and decision-makers.[cite:32][cite:35]

8. Robustness to Measurement Error and Missing Data

Given IEH’s dependence on surveys, administrative records, and geospatial products, robustness to data issues must be explicitly tested.[cite:23][cite:26]

- **Monte Carlo simulations:** create synthetic replicas of input datasets by introducing controlled perturbations such as $\pm 5\text{--}10\%$ deviations on key indicators and structured non-response patterns, then recompute IEH to assess effects on scores and rankings.[cite:23][cite:26]

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- **Missing-data scenarios:** compare traditional statistical approaches and machine-learning imputation models, quantifying the resulting variation in IEH and publishing explicit uncertainty bands.[cite:21][cite:23]
- **Data quality indicators:** publish the share of imputed values, effective sample size, and estimated margins of error so users can incorporate reliability into interpretation.[cite:21][cite:41]

9. Technical Architecture and Role of AI

- Cloud-based ETL pipelines with version control and traceability.[cite:35]
- AI models for missing-data imputation, short-term prediction of IEH declines (1–6 months), and Bayesian parameter optimisation.[cite:23][cite:35]
- Explainable AI techniques such as SHAP values to identify which indicators drive IEH changes at global and local levels.[cite:35]
- Strong privacy protections based on anonymisation, aggregation thresholds, and international standards.[cite:21][cite:35]
- A global dashboard with interactive maps, time-series visualisations, regional comparators, and automated alerts.[cite:35][cite:37]

10. Rollout Plan 2026–2030

- **Phase 0 (3 months):** establish global governance arrangements with institutions such as the UN, UNICEF, OECD, and partners; finalise the indicator set and secure data-access agreements.[cite:32][cite:35]
- **Phase 1 (6–12 months, 2026):** build an MVP in around 30 pilot countries, including ETL pipelines and a baseline dashboard.[cite:35]
- **Phase 2 (2027–2028):** scale to 100+ countries, strengthen predictive models, and implement automated regional calibration.[cite:35]
- **Phase 3 (2029–2030):** achieve stable global coverage and integrate IEH into donor and government planning for adaptive policy response.[cite:35]

11. Governance, Ethics, and Risk Mitigation

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- **Multilateral consortium:** a dedicated governance body should oversee methodology, data governance, and versioning of the index.[cite:30][cite:35]
- **Systematic bias and equity assessment:** specific analyses should detect whether IEH systematically disadvantages particular groups or territories, including ethnic minorities, rural areas, highly informal economies, or single-parent households, using fairness-oriented diagnostics and adjusting weights, thresholds, and imputation procedures where necessary.[cite:29][cite:40]
- **Participation of affected communities:** methodological reviews should incorporate feedback from community-based organisations and local practitioners to validate the interpretability and perceived legitimacy of IEH scores and changes.[cite:28][cite:40]
- **Transparency:** publish methods, parameters, sensitivity results, and version histories.[cite:23][cite:29]
- **Data protection:** require consent procedures, anonymisation, and responsible-use protocols.[cite:21][cite:30]
- **Political acceptance:** engage governments and local actors early in the design process.[cite:35][cite:40]

12. Global MVP — Expected Deliverables

- **Dataset:** monthly or quarterly IEH estimates for roughly 30 pilot countries, including B, S, F, D, and uncertainty ranges.[cite:35]
- **Dashboard:** interactive maps and time-series views at country and subnational level.[cite:35][cite:37]
- **Technical report:** detailed methodology, regional parameter sets, sensitivity analyses, and policy recommendations.[cite:23][cite:35]
- **API:** public endpoints for researchers, governments, and international organisations.[cite:35]

13. Resources and Core Team

- **Core team:** 6–10 specialists combining data science, AI, social policy, and governance expertise.[cite:35]

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- **Infrastructure:** secure cloud environment for ETL, modelling, and visualisation.[cite:35]
- **Initial budget (MVP, 12 months):** approximately USD 1.2–2.5 million for a 30-country prototype, with country-level variation depending on data-access agreements and licensing needs.[cite:35]

14. Expected Benefits

By 2026: globally comparable family-centered equilibrium indicators, early-warning alerts in pilot countries, better targeting of international aid, and dashboards for policymakers.[cite:35]

By 2030: real-time adaptive social and family-oriented policies, stronger causal evidence on interventions that raise IEH and reduce systemic vulnerabilities, and more systematic use by donors and governments as an operational allocation criterion.[cite:35][cite:41]

15. Key Risks and Mitigation

- **Data quality and comparability:** addressed through transparent imputation, explicit uncertainty metrics, and strong data-governance protocols.[cite:21][cite:23]
- **Algorithmic bias:** mitigated through fairness-aware modelling, audits, and participatory review.[cite:29][cite:40]
- **Political acceptance:** improved through transparency, co-creation with national institutions, and policy-focused communication.[cite:35][cite:40]
- **Privacy and ethics:** protected through anonymisation, secure infrastructure, and adherence to international norms.[cite:21][cite:30]

16. Operational Annexes

- **A. Full formula:** $IEH = B \cdot F^{1.5} \cdot S \cdot D$
- **B. Suggested initial parameters:** $\tau = 0.08$; $k = 50$; $m = 10$
- **C. Recommended time windows:** dS over 3, 6, and 12 months; publish IEH monthly or quarterly depending on data availability.[cite:23][cite:35]

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- **D. Success metrics:** population coverage, parameter stability, correlation with HDI and related well-being indicators, and adoption by governments and donors.[cite:25][cite:44]

17. Ancient Civilizations: Historical Mapping

The historical application section can be retained as a complementary qualitative validation component. It remains useful because it illustrates how combined external shocks, low institutional strength, weak adaptability, and loss of cohesion can generate sustained declines in equilibrium across civilizations such as Rome, Han China, the Maya world, the Indus Valley, Angkor, the Aztec Empire, the Inca Empire, and the Ottoman Empire.[cite:29]

18. Validation of the HEI

18.1 Mathematical Robustness and Variable Logic

The mathematical structure of IEH is well-founded and bounded in the interval [0,1], producing a standardized indicator.[cite:23][cite:29] The equation

$$IEH = B \cdot F^{1.5} \cdot S \cdot D$$

integrates the variables multiplicatively, ensuring that if any critical component collapses, the overall index is strongly penalised. The exponent on $F^{1.5}$ acts as an institutional amplifier and remains subject to empirical adjustment through sensitivity analysis.[cite:23][cite:22]

18.2 Balance and Penalty (B)

The balance mechanism is mathematically coherent. When the gap between family capacity α_1 and social embeddedness α_2 exceeds the tolerance threshold τ , the Gaussian decay

$$B = \exp(-k(|\alpha_1 - \alpha_2| - \tau)^2)$$

introduces a non-linear penalty that captures how acute imbalances can fracture social stability.[cite:23][cite:29]

18.3 Social Energy (S) and Adaptability (D)

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Defining S as the mean of α_1 and α_2 is statistically appropriate for an aggregate state variable. Using a logistic function for adaptability normalises dynamic changes in S onto a manageable scale and prevents short-term volatility from overwhelming the entire index.[cite:23][cite:26]

18.4 Operational Feasibility and Architecture (2026–2030)

The implementation plan is realistic given existing technology and data ecosystems. Automated ETL pipelines drawing on OECD, UNICEF, Gallup, UNDP, and national statistics directly address the main challenge faced by composite indicators: obtaining harmonised, high-quality and timely data.[cite:32][cite:35][cite:41] AI-based imputation, Bayesian parameter optimisation, and explainable dashboards provide advanced analytical capacity for near real-time decision-making.[cite:23][cite:35]

18.5 Historical Coherence

The historical mapping of major civilizational declines onto IEH components offers a strong conceptual and semi-empirical validation layer. In these historical narratives, crises emerge from the convergence of external shocks with weak institutional strength, poor adaptability, and declining cohesion, which is consistent with the structure of IEH.[cite:29][cite:40]

18.6 External Validation and Generalisation Capacity

Beyond internal mathematical checks, IEH should undergo continuous external validation. Trajectories can be compared with documented timelines of social, economic, and political crises to evaluate early-warning behavior; blocked temporal and spatial cross-validation can test generalization; and core assumptions such as the shape of B , the exponent on F , and the definition of D should be re-examined every 3–5 years as evidence accumulates.

18.7 Final Applicability Conclusions

The HEI/IEH model is applicable today with current OECD, UN, and related statistical infrastructures. Its major components can be operationalized using already available indicators on family outcomes, social cohesion, household structure, and institutional family support, especially in OECD countries and increasingly in broader global datasets. The model is therefore not merely theoretically consistent but also empirically actionable, provided that implementation includes transparent calibration, uncertainty reporting, fairness review, and regular methodological revision.

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